

National Report on Human Exposure to Environmental Chemicals



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What is the National Report on Human Exposure to Environmental Chemicals?

The *National Report on Human Exposure to Environmental Chemicals* is a new publication that will provide an ongoing assessment of the exposure of the U.S. population to environmental chemicals using biomonitoring. For this Report, an environmental chemical means a chemical compound or chemical element present in air, water, soil, dust, food, or other environmental media. Biomonitoring is the assessment of human exposure to chemicals by measuring the chemicals or their metabolites (breakdown products) in human specimens, such as blood or urine.

The Report provides exposure information about people participating in CDC's ongoing national survey of the general U.S. population — the National Health and Nutrition Examination Survey (NHANES).

NHANES is unique in its ability to examine public health issues that can best be addressed through physical and laboratory examinations of the U.S. population. The first release of the Report is restricted to general U.S. population data for the year 1999 from NHANES.

The first Report provides information about levels of 27 environmental chemicals in the U.S. population. These substances include metals (e.g., lead, mercury, and uranium), organophosphate pesticide metabolites, phthalate metabolites, and cotinine (a marker of tobacco smoke exposure).



Public Health Uses of the Report

The overall purpose of the Report is to provide unique exposure information to scientists, physicians, and health officials to help prevent disease that results from exposure to environmental chemicals. Specific uses of the Report are—

- To determine whether selected environmental chemicals are getting into the bodies of Americans and the levels of these chemicals in blood and urine.
- For chemicals that have a known toxicity level, to measure the prevalence of people in the U.S. population who have elevated levels of the chemical (e.g., blood lead levels ≥ 10 $\mu\text{g}/\text{dL}$).
- To assess the effectiveness of public health efforts to reduce the exposure of Americans to specific environmental chemicals (e.g., pesticides).
- To establish reference ranges that determine whether a person has an unusually high blood or urine level of an environmental chemical.
- To track, over time, trends in the levels of exposure of the U.S. population to environmental chemicals.
- To determine whether levels of environmental chemicals are higher among minorities, children, people of low income, the elderly, women of childbearing age, or other population groups.
- To set priorities for research on human health effects of environmental chemicals.

Interpreting Data in the Report

The first release of the Report presents data for the general U.S. population for 1999 from CDC's NHANES. Because the sample size in any one year of NHANES is relatively small and for 1999 the survey was conducted in only 12 locations across the country, and because most analyses were conducted in subsamples of the population, more data will be needed to confirm these findings and to allow more detailed analysis to describe exposure levels in population subgroups.

The Report will be updated with new data each year. Next year, CDC will combine the 1999 and 2000 data from NHANES to provide updated national estimates. In the future, the Report will also include data from other large exposure studies and studies of exposure of special-population groups within the United States.

It is also important to note that just because people have an environmental chemical in their blood or urine does not mean that the chemical causes disease. Research studies, separate from the Report, are required to determine which levels of the chemical may cause disease and which levels are of negligible health concern. For some chemicals, such as lead, research studies to date provide a good understanding of health risks associated with various blood levels. For most of the other environmental chemicals, more research is needed to determine whether exposure to the chemical at levels reported here is a cause for health concern. CDC conducts such research and provides biomonitoring measurements for this type of research in collaboration with researchers in other agencies and institutions.

Pictured on the cover: CDC scientist analyzing a urine sample for environmental chemicals using isotope dilution high-resolution mass spectrometry.

R E S U L T S

Selected Percentiles and Geometric Means of Blood and Urine Levels of Environmental Chemicals (or Metabolites)

National Health and Nutrition Examination Survey, United States, 1999

	Sample size	Units	Geometric mean (95% confidence interval)	Selected percentiles (95% confidence interval) 10th 25th 50th 75th 90th				
Metals ¹								
Cadmium	3,189	µg/L	*	<LOD	<LOD	0.3 (0.2-0.3)	0.5 (0.4-0.6)	0.9 (0.7-1.1)
Lead	3,189	µg/dL	1.6 (1.4-1.8)	0.7 (0.6-0.7)	1.0 (0.9-1.1)	1.5 (1.4-1.7)	2.3 (2.2-2.6)	3.7 (3.2-4.3)
Mercury Children 1-5 years	248	µg/L	0.3 (0.2-0.4)	<LOD	<LOD	0.2 (0.2-0.3)	0.5 (0.4-0.8)	1.4 ² (0.7-4.8)
Females, 16-49 years	679	µg/L	1.2 (0.9-1.6)	0.2 (0.1-0.3)	0.5 (0.4-0.7)	1.2 (0.8-1.6)	2.7 (1.8-4.5)	6.2 (4.7-7.9)
Metals ³								
Antimony	912	µg/L	0.1 (0.09-0.12)	<LOD	0.05 (0.03-0.07)	0.1 (0.09-0.12)	0.19 (0.16-0.21)	0.29 (0.27-0.34)
Barium	779	µg/L	1.6 (1.5-1.7)	0.3 (0.3-0.4)	0.8 (0.7-0.9)	1.7 (1.5-1.9)	2.9 (2.7-3.3)	5.5 (4.2-6.2)
Beryllium	1,007	µg/L	*	<LOD	<LOD	<LOD	<LOD	<LOD
Cadmium	1,007	µg/L	0.32 (0.30-0.33)	0.10 (0.08-0.12)	0.18 (0.15-0.19)	0.33 (0.29-0.35)	0.57 (0.52-0.62)	0.95 (0.85-1.04)
Cesium	1,006	µg/L	4.7 (4.2-5.2)	1.8 (1.4-2.2)	3.3 (2.9-3.6)	5.3 (4.7-5.8)	7.2 (6.7-8.0)	9.6 (8.5-11.6)
Cobalt	1,007	µg/L	0.36 (0.32-0.40)	0.11 (0.08-0.14)	0.23 (0.19-0.26)	0.40 (0.35-0.41)	0.60 (0.54-0.68)	0.89 (0.79-1.10)
Lead	1,007	µg/L	0.80 (0.68-0.91)	0.21 (0.15-0.26)	0.42 (0.34-0.51)	0.80 (0.72-0.88)	1.36 (1.17-1.69)	2.21 (1.89-2.72)
Molybdenum	904	µg/L	48.4 (43.6-53.2)	13.1 (10.8-17.3)	27.6 (23.4-32.8)	53.3 (47.3-61.5)	86.6 (78.6-97.5)	140 (120-174)
Platinum	1,007	µg/L	*	<LOD	<LOD	<LOD	<LOD	<LOD
Thallium	974	µg/L	0.19 (0.17-0.20)	0.07 (0.06-0.07)	0.12 (0.10-0.13)	0.21 (0.19-0.23)	0.30 (0.28-0.33)	0.42 (0.39-0.45)
Tungsten	892	µg/L	0.10 (0.09-0.12)	<LOD	0.05 (0.03-0.06)	0.10 (0.08-0.11)	0.18 (0.16-0.22)	0.32 (0.27-0.45)
Uranium	1,006	µg/L	0.008 (0.006-0.011)	<LOD	<LOD	0.007 (0.004-0.010)	0.014 (0.009-0.030)	0.034 (0.022-0.053)

<LOD means below the limit of detection of the analytical method.

*Not calculated. Proportion of results below the limit of detection was too high to provide a valid result.

(1) Lead and cadmium are measured in blood among people aged 1 year and older; mercury is measured in blood among age groups specified above. Blood levels by selected demographic groups are available for lead and cadmium at www.cdc.gov/nceh/dls/report.

(2) Estimate meets minimum standards of reliability but should be interpreted with caution.

(3) Measured in urine in a subset of people aged 6 years and older.

R E S U L T S

Selected Percentiles and Geometric Means of Blood and Urine Levels of Environmental Chemicals (or Metabolites)

National Health and Nutrition Examination Survey, United States, 1999

	Sample size	Units	Geometric mean (95% confidence interval)	Selected percentiles (95% confidence interval)				
				10th	25th	50th	75th	90th
Organophosphate Pesticide Metabolites⁴								
Dimethylphosphate	703	µg/L	1.84 (1.10-2.59)	<LOD	0.80 (0.36-1.11)	1.67 (1.04-2.86)	3.79 (2.38-7.46)	7.43 (5.43-17.3)
Diethylphosphate	703	µg/L	2.55 (1.33-3.78)	0.78 (0.70-0.90)	1.09 (0.93-1.31)	1.85 (1.19-4.11)	4.87 (2.58-14.0)	10.6 ⁵ (6.29)
Dimethylthiophosphate	703	µg/L	2.61 (1.77-3.45)	<LOD	0.72 (0.13-1.73)	3.80 (2.93-4.53)	9.00 (7.35-12.3)	22.9 (18.7-30.7)
Diethylthiophosphate	703	µg/L	0.81 (0.69-0.94)	0.51 (0.41-0.53)	0.58 (0.55-0.59)	0.70 (0.64-0.78)	0.98 (0.78-1.45)	1.52 (1.16-2.91)
Dimethyldithiophosphate	703	µg/L	0.51 (0.39-0.62)	<LOD	<LOD	0.60 (0.39-0.78)	2.05 (1.65-2.42)	5.43 (3.16-10.3)
Diethyldithiophosphate	703	µg/L	0.19 (0.14-0.23)	0.08 (0.07-0.08)	0.09 (0.09-0.09)	0.14 (0.09-0.26)	0.30 (0.25-0.39)	0.54 (0.44-0.86)
Phthalate Metabolites⁴								
Mono-benzyl phthalate	1,029	µg/L	17.4 (14.1-20.7)	3.5 (2.2-4.5)	8.0 (5.9-9.8)	18.5 (15.4-22.6)	38.6 (31.5-48.7)	82.3 (64.0-101)
Mono-butyl phthalate	1,029	µg/L	26.7 (23.9-29.4)	5.9 (4.6-7.3)	13.2 (10.5-15.4)	27.5 (24.6-31.5)	53.8 (51.2-59.7)	98.6 (89.1-122)
Mono-cyclohexyl phthalate	1,029	µg/L	*	<LOD	<LOD	<LOD	<LOD	<LOD
Mono-ethyl phthalate	1,024	µg/L	176.0 (132-220)	27.7 (17.5-38.3)	61.5 (43.1-80.0)	171 (121-226)	424 (362-563)	1,160 (971-1,350)
Mono-2-ethylhexyl phthalate	1,029	µg/L	3.5 (3.0-4.0)	<LOD	1.5 (0.8-1.9)	3.3 (3.0-3.8)	7.7 (6.1-9.6)	13.6 (11.2-17.3)
Mono-isononyl phthalate	1,029	µg/L	*	<LOD	<LOD	<LOD	<LOD	4.3 (0.6-22.3)
Mono-n-octyl phthalate	1,029	µg/L	*	<LOD	<LOD	<LOD	<LOD	1.9 (1.2-3.5)
Cotinine⁶	2,263	ng/mL	*	<LOD	<LOD	<LOD	0.15 (0.11-0.23)	0.52 (0.38-1.01)

<LOD means below the limit of detection of the analytical method.

*Not calculated. Proportion of results below the limit of detection was too high to provide a valid result.

(4) Organophosphate pesticide metabolites are measured in urine in a subset of people aged 6 to 59 years. Phthalate metabolites are measured in urine in a subset of people aged 6 years and older.

(5) Upper end of the 95% confidence interval cannot be reliably estimated.

(6) Measured in serum among nonsmokers aged 3 years and older. Serum levels for selected demographic groups are available for cotinine at www.cdc.gov/nceh/dls/report.

Major Findings of the Report

First-time information about exposure levels for the U.S. population

The Report provides information about exposure to environmental chemicals in the U.S. population to scientists, public health officials, and the public. The 1999 Report provides measures of exposure for 27 chemicals in the U.S. population based on blood and urine samples from people participating in the 1999 National Health and Nutrition Examination Survey (NHANES 1999). For three chemicals -- lead, cadmium, and cotinine -- CDC has previously assessed the population's exposure through NHANES, and this report provides new data for the 1999 calendar year. The Report provides information for the first time on the U.S. population's exposure to 24 additional environmental chemicals (metals, organophosphate pesticides and phthalates). Because the sample size in one year of NHANES is relatively small and because the 1999 survey was only conducted in 12 locations across the country, data from additional years of the survey will be needed to confirm these findings.

Reference range values for physicians and health researchers

Physicians use "normal" ranges for laboratory results to determine whether their patients have high or low values that would indicate a health problem. These normal ranges are obtained from people who are generally healthy. In the Report, CDC determined "reference ranges" for 24 environmental chemicals from a group of people not known to have any specific exposure to the chemical beyond that experienced in the general population. Sometimes these reference ranges are referred to as background exposure levels.

Reference ranges are extremely helpful to physicians and health researchers because levels above the reference range usually indicate exposure to a particular source. For example, if a physician was concerned about a patient's potential exposure to cadmium and measured a cadmium level in the patient's urine, the results could be compared to the population reference range in the Report. A cadmium level similar to those found in the Report would indicate exposure no different from those found in the general population, and a level much higher than those found in the Report would indicate that there may have been an unusual exposure to cadmium worthy of further investigation.

Decline in blood lead levels among children since 1991-1994

Since 1976, CDC has measured blood lead levels as part of the NHANES. Results presented in the Report for 1999 show that the geometric mean blood lead level for children aged 1-5 years has decreased to 2.0 micrograms per deciliter ($\mu\text{g}/\text{dL}$), from 2.7 $\mu\text{g}/\text{dL}$, the geometric mean for the period 1991-1994. This decrease documents that blood lead levels continue to decline among U.S. children when considered as a group -- highlighting the success of public health efforts to decrease the exposure of children to lead. However, special populations of children at high risk for lead exposure (e.g., those living in homes containing lead-based paint or lead-contaminated dust) remain a major public health concern.

Reduced exposure of the U.S. population to environmental tobacco smoke

Cotinine is a metabolite of nicotine that tracks exposure to environmental tobacco smoke (ETS) among non-smokers -- higher cotinine levels reflect more exposure to ETS. ETS has been identified as a known human carcinogen. From 1988 through 1991, as part of the NHANES III survey, CDC determined that the median level (50th percentile) of cotinine in nonsmokers in the United States was 0.20 nanograms per milliliter (ng/mL). Results from the 1999 Report showed that the median cotinine level among people aged 3 years and older has decreased to less than 0.050 ng/mL -- more than a 75% decrease. This reduction in cotinine levels objectively documents a dramatic reduction in exposure of the general U.S. population to environmental tobacco smoke since 1988-1991. However, since more than half of American youth are still exposed, ETS remains a major public health concern.

Better assessment of children's and women's exposure to mercury

The 1999 Report provides important new data on blood mercury levels among children aged 1-5 years and among women of childbearing age (16-49 years old). The geometric mean of blood mercury levels among children (0.3 $\mu\text{g}/\text{L}$) was about 25% of the geometric mean of blood mercury levels among women of childbearing age (1.2 $\mu\text{g}/\text{L}$). Compared with an adult, the fetus and child are usually more vulnerable to the effects of metals. Consequently, when addressing mercury exposures, health officials are particularly careful to protect the fetus and child. The Report provides data for children and levels for women of childbearing age that reflect levels of mercury to which the fetus is exposed. Scientists will use these new data to better estimate health risks for the fetus, children, and women of childbearing age from potential sources of mercury exposure.

Setting priorities for research on phthalates

Phthalates are compounds commonly used in consumer products such as soap, shampoo, hair spray, and many types of nail polish. Some phthalates are used in flexible plastics such as blood bags and tubing. Animal research has focused on evaluating reproductive effects of phthalates. For the 1999 Report, CDC scientists measured metabolites of seven major phthalates. Di-2-ethylhexyl phthalate (DEHP) and di-isononyl phthalate (DINP) are the two phthalates produced in greatest quantity, with diethyl phthalate (DEP) and dibutyl phthalate (DBP) produced in much lower quantities. However, data from the Report showed levels of metabolites of DEP and DBP to be much higher in the population than metabolites of either DEHP or DINP.

These new data have prompted CDC to conduct additional studies to explain these findings by examining the pathways by which these phthalates get into people's bodies. The data also indicate that health research needs to focus on DEP and DBP, given that levels of their metabolites are much higher in the general U.S. population.

Future Plans

The *National Report on Human Exposure to Environmental Chemicals* will be updated each year with new data for the general population. Next year, CDC will combine the 1999 and 2000 data from NHANES to provide updated national estimates. For the general population, current plans are for the Report to continue to measure these 27 chemicals and gradually expand the number measured until approximately 100 environmental chemicals are measured each year. Chemicals under consideration for future Reports include carcinogenic volatile organic compounds, carcinogenic polyaromatic hydrocarbons, dioxins, furans, polychlorinated biphenyls, trihalomethanes, haloacetic acids, carbamate pesticides, and organochlorine pesticides.

Future editions of the Report will provide more detailed assessments of exposure levels among different population groups defined by sex, race/ethnicity, age, urban/rural residence, education level, income, and other characteristics. In addition, over time CDC will be able to track trends in exposure levels.

Future Reports also will include exposure information for special-exposure populations from studies of people exposed from localized or point source exposures (e.g., people who eat mercury-contaminated fish from a polluted river) and studies of adverse health effects resulting from exposure to varying levels of environmental chemicals.

Data provided in future Reports will help us answer the following questions:

- Are exposure levels increasing or decreasing over time?
- Are public health efforts to reduce exposure working?
- Do certain groups of people have higher levels of exposure than others?



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